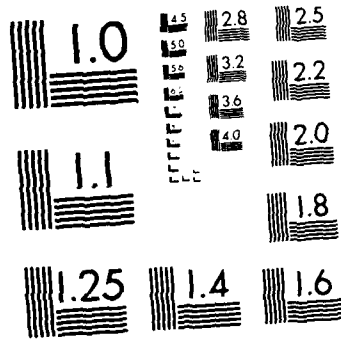


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Figure 1 displays a series of 24 grayscale images arranged in two rows of 12, illustrating the progression of a chemical reaction. The top row shows a reaction involving a yellow precipitate, and the bottom row shows a reaction involving a white precipitate. The images are labeled with chemical formulas and numbers 1 through 12, indicating the sequence of the reaction over time.

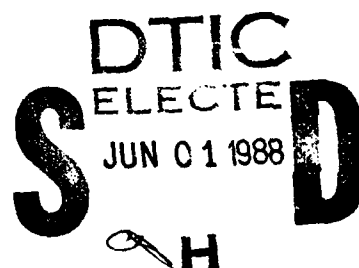


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**CENTRAL SEROUS CHORIORETINOPATHY
IN USAF AVIATORS: A REVIEW**

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March 1988



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USAF SCHOOL OF AEROSPACE MEDICINE
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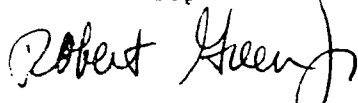
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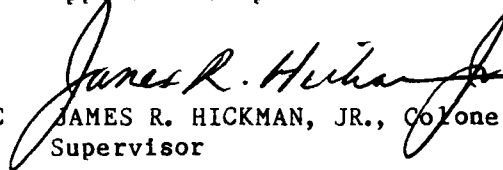
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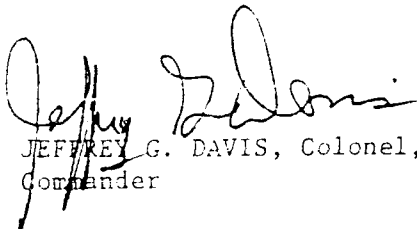
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<p>INTRODUCTION.—Idiopathic central serous chorioretinopathy (ICSC) is an uncommon disease with the potential to cause loss of visual acuity, decreased color vision, and decreased depth perception. These visual changes may become permanent and require removal of aviators from flight status. METHODS. This study reviews 55 eyes of 47 USAF aviators with ICSC examined at the United States Air Force School of Aerospace Medicine (USAFSAM), Brooks Air Force Base, Texas. Clinical and aeromedical findings, both on initial and on follow-up ophthalmic examination were studied. RESULTS. Ninety-seven percent of aviators otherwise medically qualified were ultimately returned to flight status. Overall, 51% had recurrent episodes, 17% had bilateral disease, and 13% underwent laser photocoagulation. Visual acuity correlated with active disease, and there was a trend toward poor stereopsis and diminished color vision with worsening visual acuity. Eighty-six percent attained a final visual acuity of 20/20 or better. On final examination, 90% had normal stereopsis, 67% had normal color vision, and 49% had a normal central visual field. Eyes with recurrent disease tended to have degraded final visual acuity, stereopsis, color vision, and central visual field. CONCLUSION.—The visual and aeromedical prognosis from a single attack of ICSC is generally favorable, but repeated attacks can lead to a significant decrease in visual functions that may jeopardize flying status.</p>				
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INTRODUCTION

Idiopathic central serous chorioretinopathy (ICSC) was first described by Von Graefe in 1866, who called it "Recurrent Central Retinitis" (48). A number of articles have detailed the history of this well-described condition and the etiologies proposed (3,5,15,20,22,49,50). It was not until the development of the technique for rapid-sequence photographic fluorescein angiography of the fundus in 1961, however, that the pathogenesis of the condition could be confirmed (39). In his landmark article in 1967, Gass demonstrated that a focal process in the choriocapillaris beneath the macula, resulting in increased choroidal vascular permeability, was responsible for the abnormal transudation of fluid and the subsequent serous detachment of the retinal pigment epithelium and the retina (12). The etiology of this condition, however, is still unknown.

ICSC patients are usually healthy adults; their average age is 38-43 years (2,8,29,33,35,38,47). Males are affected more commonly than females in ratios ranging from 2:1 to 7:1 (2,5,8,25,29,32,38,47). Patients usually complain of mildly decreased, blurred or distorted vision in one eye, although bilateral disease does occur in from 2-30% of patients (4,5,10,13,24,25,27,33,35,36,38,47). They often have the following abnormalities: positive scotoma 83%, metamorphopsia 65-84%, micropsia 37-86%, and Amsler grid changes 95% (33,47). Abnormal color perception is also reported (6,11,21,22,26,34,45,55). Fundus examination usually reveals a circular, serous retinal and retinal pigment epithelial detachment in the macular area involving the fovea. A fluorescein angiogram may demonstrate a focal leak from the choroidal vasculature through Bruch's membrane in from 64-100% of patients (8,16,28,53,54).

The serous detachment and visual symptoms last an average of 3-6 months without treatment (17,23,33,36). Most patients recover good visual acuity; 36-86% obtain a final visual acuity of 20/20 (2,8,10,13,16,17,24,28,29,33,36,38). No medical treatment has proven beneficial (5,13). Photocoagulation of the actual leaking area seals the leak at the retinal pigment epithelium, probably by debridement, and serves to shorten the course of the detachment (1,2,12,16,27,28,31,42,46,51,52,54,56).

Only two papers have dealt with ICSC in flyers. One is a 1972 report from our department (9), and the other is a report from the Israeli Air Force (17).

Over the past 23 years (1964-1987), 47 flyers with a history of ICSC were referred to the Ophthalmology Branch at USAFSAM for flying status evaluation. The records of these flyers were reviewed. This paper summarizes our findings and analyzes the reasons which led to our recommendations for, ultimately, returning 97% of the aviators to flight status.

METHODS AND MATERIALS

Patient Selection

The Ophthalmology Branch at USAFSAM serves a consultant function to the USAF Surgeon General for aviators who have been grounded for a disqualifying

ocular condition or disease. USAF aviators, also known as flyers, are those personnel required to maintain Flying Class II or III medical standards (i.e., pilots, navigators, other aircrew members and air traffic controllers). Patients are generally referred from their local flight surgeon to USAFSAM once diagnosis, treatment and resolution or stabilization of the ocular problems have occurred.

Patient Evaluation

All patients received a full, dilated ophthalmologic examination and special testing that included: Amsler grid; color testing with Pseudoisochromatic Plates - PIP ($\geq 10/14$ passes); stereopsis testing with the Vision Testing Apparatus - VTA (25 arc seconds passes), Vernoeff device (33 arc seconds passes), or Howard-Dolman device (11 arc seconds passes). Most patients with suspected active disease underwent fluorescein angiography of the ocular fundus.

RESULTS

Patients

Thirty-six of the aviators were pilots; six were navigators; four occupied other crew positions; one was an air traffic controller. Nineteen patients had only the right eye involved; twenty had only the left eye involved; eight ultimately had both eyes affected (17%). The mean age at diagnosis was 36.3 years (range 24-49 years). All patients were male Caucasians. Twenty-two had a smoking history; twenty-two did not; information was not available on three.

Although the aviators did not present for acute management, fourteen out of fifty-five eyes (25%) had active disease on initial evaluation as manifested by a leak on fluorescein angiography and/or serous detachment. Twenty-four out of fifty-five eyes (44%) were seen within six months of the diagnosis. Inactive ICSC was an incidental finding in seven eyes of seven aviators (13%).

Thirty-eight of the fifty-five affected eyes (69%) were seen at least twice. The mean follow-up was 2.3 years with a range from three months to thirteen years. Twenty-four patients (51%) had a recurrent episode of ICSC. Nine of these suffered a single recurrence in the same eye; seven had multiple recurrences in the same eye; three had a single recurrence in the opposite eye; and five had multiple recurrences in both eyes. Two (5%) had active disease at the time of the most recent examination.

Six of the forty-seven aviators (13%) underwent laser photocoagulation for ICSC (7 eyes). One was treated prior to his first USAFSAM evaluation. One flyer was treated both before and after his first visit. The other four aviators were treated only after their first USAFSAM evaluation.

Symptoms

Five aviators (11%) were asymptomatic at the time of diagnosis, while the remaining forty-two (89%) complained of one or more symptoms. Table 1 lists the frequency of ICSC symptoms.

TABLE 1. FREQUENCY OF ICSC SYMPTOMS

Symptom	# of Eyes	% of Eyes
Blurred Vision	33	70%
Metamorphopsia (distorted images)	14	30%
Micropsia (small images)	8	17%
Central Scotoma	7	15%
Change in color vision	3	6%
Asymptomatic	5	11%

Visual Acuity

Visual acuity was decreased during active disease but improved with resolution of the leak. Eighty-two percent (45/55) of eyes had 20/20 or better vision on the initial evaluation. Five eyes had a visual acuity between 20/20 and 20/30, and the remaining five eyes ranged from 20/40 to 20/70. Visual acuity during the acute episode was not available, except for the fourteen eyes with active disease at the time of the evaluation. Ninety percent of the eyes without active ICSC had 20/20 or better vision, while only 57% of the eyes with active disease had 20/20 or better vision.

Fig. 1 displays the visual acuity from the most recent evaluation (six eyes with active disease were excluded). The visual acuity tended to improve with resolution of the disease, as 86% recovered a visual acuity of 20/20 or better.

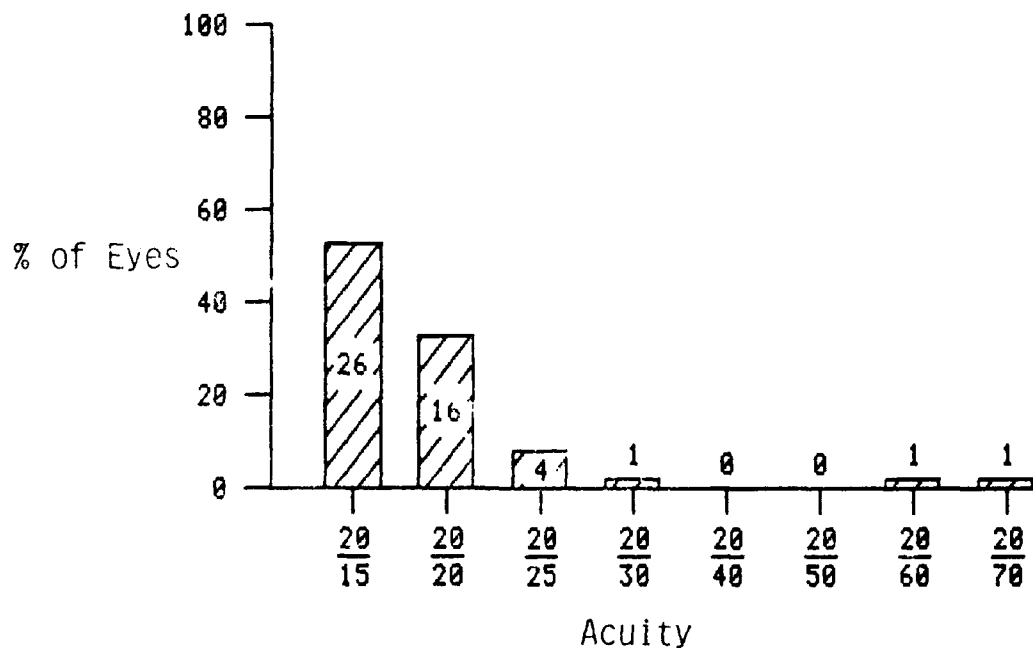


Figure 1. Recovered visual acuity.

Stereopsis

Abnormal stereopsis was associated with decreased visual acuity. Initial stereopsis testing was obtained on forty-five of forty-seven patients. Only six aviators (13%) were not able to pass the VTA-ND, Vernoeff or Howard-Dolman tests. Four of these had active disease, as well as a visual acuity of 20/30 or worse. However, eleven of the thirteen patients with active disease (fourteen eyes) were tested and seven (64%) passed.

The bar graph in Fig. 2 depicts the trend of poor stereopsis with decreasing visual acuity. Notice that 100% of the aviators with 20/15 visual acuity were able to pass the stereopsis testing (25 arc sec), while 87% of those with 20/20 visual acuity and only 50% of those with 20/25 or worse visual acuity were able to pass. The visual acuity groupings were chosen because 20/15 is the best corrected visual acuity of a majority of aviators, 20/20 is required to remain on flying status, and 20/25 or worse requires a waiver to continue flying duties.

Stereopsis tended to recover with resolution of the disease, as 90% of aviators with inactive disease ultimately achieved 25 arc sec.

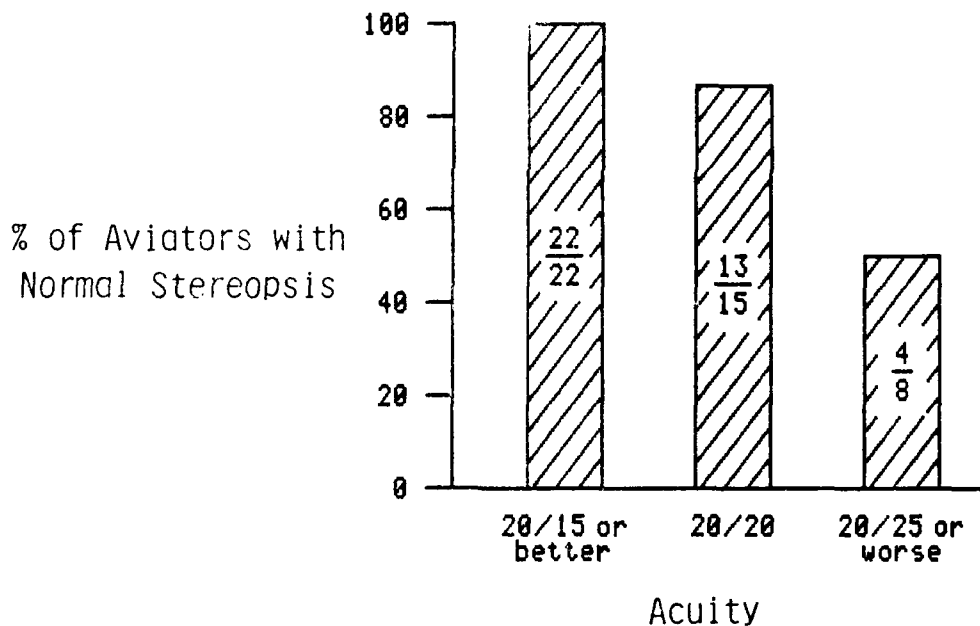


Figure 2. Visual acuity and stereopsis.

Color Vision

Eyes with abnormal color vision were associated with diminished visual acuity. Fifty-four out of fifty-five eyes were initially tested monocularly with pseudoisochromatic color plates (PIP). Two of these eyes had mild congenital deuteranopia; they are eliminated from the statistical calculations. Forty-two eyes (81%) were normal. Nine eyes (17%) had abnormal color vision in the affected eye, incorrectly identifying two or more color plates than the healthy eye. One eye failed, incorrectly identifying five or more out of fourteen plates. Thirteen out of fourteen eyes with active disease were tested; five (38%) had normal color vision; eight (62%) had abnormal color vision.

The bar graph in Fig. 3 depicts the trend of diminishing color vision with decreasing visual acuity. Notice that 89% of the eyes with 20/15 visual acuity had normal color vision, while 81% of the eyes with 20/20 visual acuity and only 33% of the eyes with 20/25 or worse visual acuity had normal color vision.

Color vision tended to recover with resolution of the disease, as 87% of eyes with inactive disease ultimately retained normal color vision.

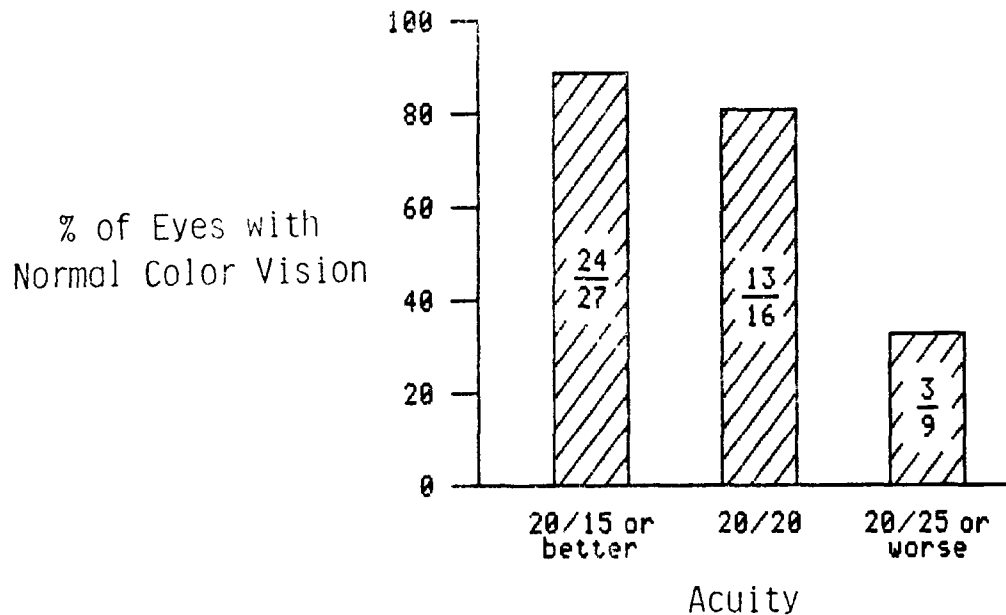


Figure 3. Visual acuity and color vision.

Central Visual Field

Metamorphopsia on Amsler grid testing did not correlate with visual acuity or active disease. The central visual field was tested with an Amsler grid on forty-three of the fifty-five involved eyes (78%). Twelve eyes (28%) were normal, while thirty-one (72%) showed distortion. Twelve of the fourteen eyes with active disease were tested. Three eyes (25%) were normal, while nine (75%) showed metamorphopsia.

The bar graph in Fig. 4 demonstrates the variable relationship between central visual field distortion and visual acuity.

Central visual field distortions tended to normalize over time. Ten eyes demonstrated a change, eight from abnormal (metamorphopsia) to normal and two from normal to abnormal. Forty-nine percent of eyes with inactive disease recovered a normal central visual field.

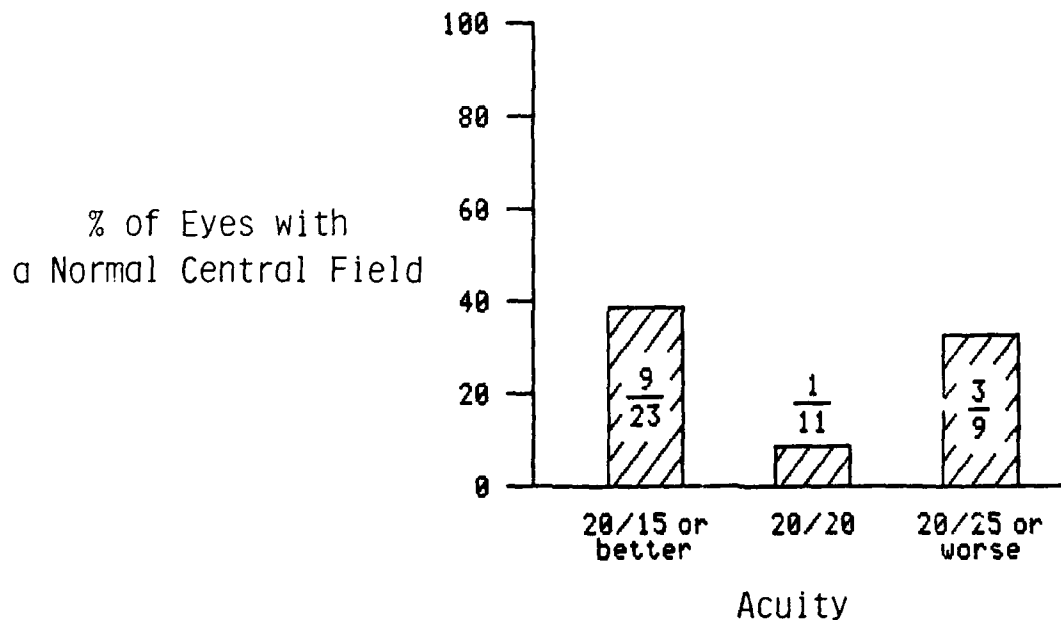


Figure 4. Visual acuity and central field.

Fluorescein Angiography

Fluorescein angiography was performed on thirty-five of the fifty-five eyes (64%). Fourteen eyes (40%) had an abnormal angiogram, demonstrating either a leak or serous detachment (i.e., active disease). Eyes with inactive disease demonstrated retinal pigment epithelial defects of varying degrees.

Recurrence

Eyes with recurrent episodes of ICSC tended to have worse visual acuity, stereopsis, color vision, and central visual fields. The bar graph in Fig. 5 displays the effect of multiple episodes of ICSC on these psychophysical functions. The six aviators with active disease on the final evaluation are eliminated. Notice, as you move from one episode of ICSC to two episodes and then to three, that each of the psychophysical functions is normal in a lower percentage of aviators: 20/20 or better visual acuity goes from 92% to 83% to 67% of aviators; normal stereopsis from 100% to 83% to 67%; normal color vision from 97% to 90% to 55%; normal central visual field from 57% to 60% to 13%.

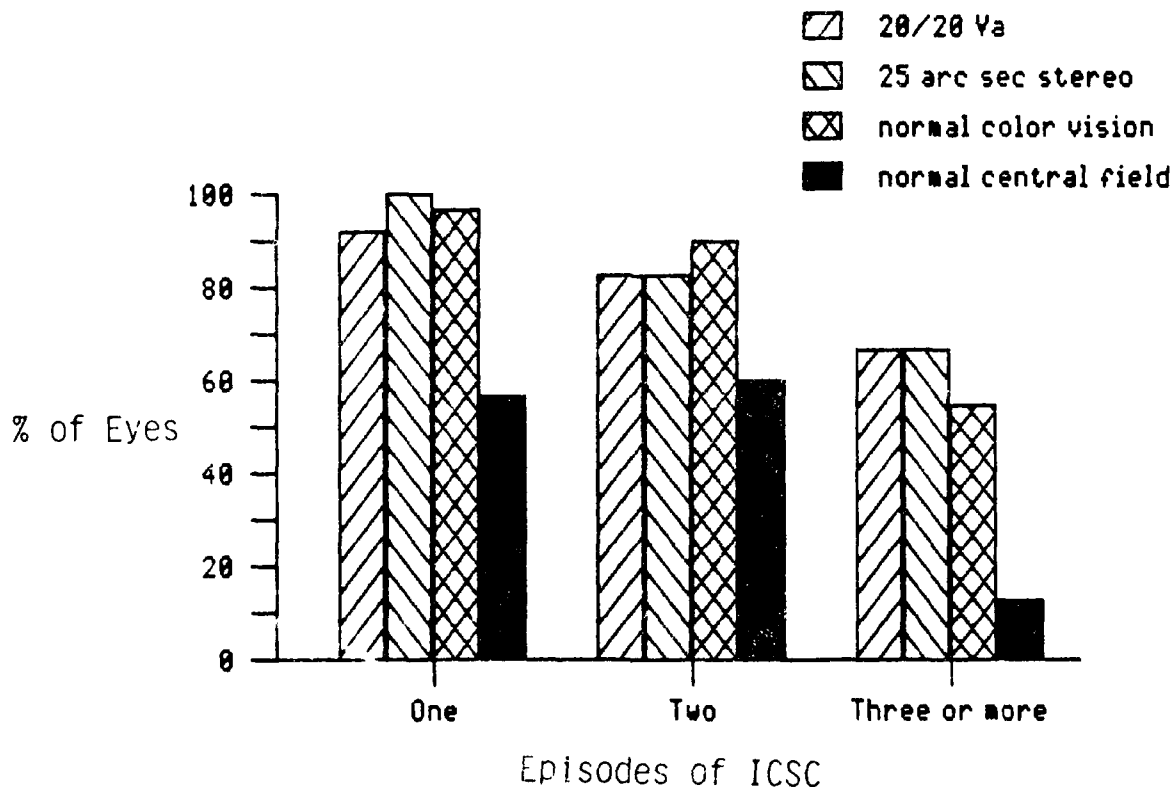


Figure 5. Effect of recurrence on psychophysical functions.

Aeromedical Disposition

Waiver consideration was not applicable in four aviators who retired. Five others were grounded for medical reasons other than ICSC and are not discussed here. Fig. 6 contains an aviator flow chart of the aeromedical disposition of the remaining thirty-eight aviators. Begin at the left side of the chart. You can see that thirty-one (82%) initially received a waiver to continue flying duties. Three of the thirty-one flyers had an eye with a visual acuity worse than 20/20. One was a pilot with 20/30 visual acuity in one eye, who had normal stereopsis, normal color vision, no Amsler grid changes and inactive disease. Each of the other two flyers had one eye with active disease. One was a flight engineer whose affected eye had 20/50 vision, and the other was a pilot whose affected eye had 20/30 visual acuity. Four other aviators had an eye with active disease and were granted waivers, but in each case visual acuity was 20/20 or better. Continue to the right and you can see that three of the thirty-one aviators (10%), initially granted a waiver, were subsequently grounded for recurrent ICSC. They ultimately returned to flying status.

Return to the left of the flow chart and notice that seven aviators (18%) did not initially receive a waiver solely due to active ICSC. They were placed in down status [sic] Involving Flying] status. The visual acuities in their diseased eyes were 20/20+ in three, 20/25 in one and 20/40 in three. Six of the seven ultimately returned to flying status.

Only one aviator out of thirty-eight (3%) did not return to flying status because of ICSC. He was an air traffic controller initially disqualified because of continued awareness of central visual distortion. He did not return for a re-evaluation.

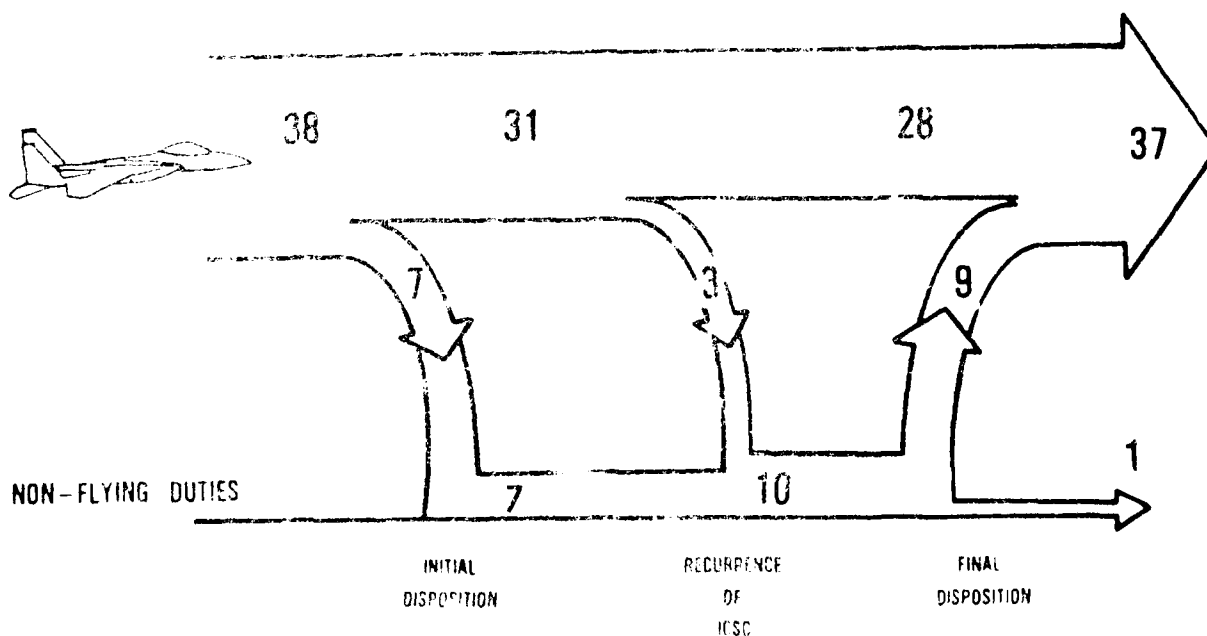


Figure 6. ICSC aviator flow chart.

ICSC NOT REFERRED TO USAFSAM

Review of the USAF waiver file revealed that ICSC was diagnosed in fifty-three other aviators not referred to USAFSAM for evaluation. They received waivers either from their major air command surgeon general or the USAF Surgeon General. Twenty-eight were pilots; thirteen were navigators; six were flight engineers; and six occupied other crew positions. Twenty-two (42%) are still on active duty. Forty-seven (89%) were male; however, sex was not noted for the other six. Forty (75%) were Caucasian. The race is annotated as "other" in seven aviators and not listed in six.

Eleven (21%) received an indefinite waiver, and forty (75%) received a temporary waiver. The other two were disqualified from flying duties for medical problems other than ICSC. Six of the aviators (11%) also received a waiver for decreased visual acuity. Six (11%) carried the diagnosis of posterior subcapsular cataract.

DISCUSSION

Flying Waivers

Our data continue to demonstrate that most aircrew members can be safely returned to full flying duties after single and multiple episodes of ICSC. In our 1972 report, 81% of flyers were visually qualified to return to flight status, although one of these was disqualified for other medical reasons (9). This continues to be the case. Initially, 82% of the aviators were felt to be qualified for flying. Those with active disease were encouraged to await resolution, with or without laser treatment, and return for re-evaluation. Only one aviator who was otherwise medically acceptable did not receive a waiver. He did not return for follow-up. Our ultimate cockpit return rate for experienced aviators was, therefore, 97%. Gross et al. in 1986 reported a cockpit return rate of 81% (17).

Initial Symptoms

Our data support the findings of others quoted earlier that the most common symptoms during an attack of ICSC are blurred vision, metamorphopsia, micropsia, and central visual field changes.

Final Visual Acuity

The percentage of eyes with inactive disease having a final visual acuity of 20/20 or better was 86%.

Other studies have shown that the final visual acuity is statistically unaffected by laser photocoagulation of the choroidal leak (8,10,16,28,29,41,52,56). Our data further demonstrate that laser treatment does not affect final visual acuity.

Dellaporta (8) has shown that the percentage of eyes with a severe decrease in final acuity did not differ between untreated and laser-treated eyes (8% vs. 10%). In our study, only one patient who received laser therapy, and one patient who did not, had a residual visual acuity worse than 20/40.

Amsler Grid

Central visual field defects can persist. Our finding of a residual central visual field abnormality, as measured by the Amsler grid, in 51% of eyes with inactive disease is in accord with other reports--81% Natsikos (37) and 89% M.L. Klein (24). Even with recovery of good visual acuity (20/30 or better) 10-21% of patients report troublesome residual central field changes (25,38). It should be noted that our patients obtain a significant secondary benefit (continuing on flying status) from not calling attention to adverse symptoms.

Stereopsis

No data exist in the literature regarding stereopsis, except for our department's 1972 report (9).

Our present data demonstrate that 90% of aviators with inactive disease on final examination have "normal" stereopsis, using one of three tests described.

Color Vision

Color abnormalities in ICSC have been studied. Mori in 1916 was the first to note a shift of the Rayleigh Equation toward the red with the Nagel Anomaloscope (34). Subsequent reports have also demonstrated this pseudoprotanomalous pattern in patients with active disease (6,21,45,55).

Kitahara first noted a blue-yellow defect in 1936 (22). Others have also demonstrated a blue-yellow Tritan axis on the Farnsworth Munsell 100-Hue test in patients with active disease (6,11,45,55). Folk reported that 38% of his ICSC patients had a Tritan defect and 46% had a nonspecific pattern (11).

Krill found that, in macular disease, performance on color tests paralleled the visual acuity (26). Patients with 20/30 acuity usually had mild abnormalities on the Nagel anomaloscope and sometimes on the 100-Hue, and an acuity of 20/40 or worse resulted in abnormalities on both tests in most cases.

Our data support Krill's findings, in that normal color vision correlated strongly with good visual acuity.

Recurrences

Reports have shown that the recurrence rate for untreated eyes varies between 7.7 and 57% (5,13,17,23-25,29,33,38,47). The recurrence rate for laser-treated eyes in two studies was 19% and 6% (14,55). Studies that have compared untreated and laser-treated eyes give conflicting results; 30-60% untreated vs. 0-50% treated (8,10,16,36,39,53,54). Our data support the conclusion that the rates are similar.

Electrophysiology

Electrophysiologic abnormalities have been reported in ICSC. In active disease, the visual evoked potential (VEP) latency may be prolonged (11,18,40,44), the electroretinogram (ERG) "a" wave amplitude may be decreased (40), and the critical flicker-fusion frequency may be decreased (11,18). With resolution of the serous detachment, published reports draw conflicting conclusions as to whether the abnormalities of critical flicker-fusion and VEP persist (18) or resolve (11,44).

Clinically, a relative afferent pupillary defect has been noted in 15 of 18 involved eyes (11), the Pulfrich phenomenon has been demonstrated (19), and the photostress recovery time is prolonged (30,37,43). These all return to normal with resolution of the serous detachment.

Therefore, even though vision may be normal during an attack of ICSC, the eye does not function normally.

Recommendations

USAF Regulation 160-43 mandates that the aviator must be temporarily grounded for the active ocular disease. This is appropriate considering the abnormalities in visual acuity, stereopsis, color vision, Amsler grid and electrophysiology testing present during active episodes. Major criteria which may adversely affect a recommendation for returning a flyer to the air have not changed. These criteria include active disease, a decrease in visual acuity, central visual field defects and loss of stereopsis.

Residua of the condition which may impact on the decision, but which in themselves do not prevent a return to flight status, include minor Amsler grid changes, small visual field defects and monocular color vision deficits.

Laser photocoagulation is recommended in accordance with the principles of Gass (13) and De Laey (7):

- * Serous detachment longer than 4 months
- * Site of leakage outside the capillary-free zone
- * Recurrent serous detachment in an eye with a permanent visual deficit due to ICSC
- * Initial serous detachment in the second eye and permanent loss of central vision in the opposite eye due to prior ICSC

Due to potentially vision-threatening complications, laser photocoagulation is done only after full patient counseling and informed consent.

Summary

The functional recovery of flyers with ICSC is generally good. Eighty-six percent attained 20/20 or better visual acuity. Ninety percent had 25 arc sec of stereopsis. Eighty-seven percent recovered normal color vision. Forty-nine percent retained a normal central visual field. However, the recurrence rate was 51%, and each of the psychophysical functions worsened with recurrent episodes of ICSC. The aeromedical disposition of experienced flyers is generally good. Only 1 of 38 did not return to flight status due to ICSC.

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